Some Observations on Trypanosoma pecorum (*Bruce*) *and* T. uniforme (*Bruce*).

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The fact that antelope play a considerable part in nature as a reservoir for *T. gambiense* has now been thoroughly established. Both laboratory and field results agree in confirming the suspicion which for some time past has attached to these animals. In the case of *T. gambiense*, however, there is nothing very remarkable in the observation that the presence of the trypanosome in their blood apparently exerts no harmful effect on the antelope. *T. gambiense* cannot be considered as a fatal trypanosome for ruminants generally. In the case of *T. pecorum*, however, matters are different. This trypanosome, according to Bruce and his collaborators, causes a rapidly fatal disease in cattle and domestic animals generally. Though apparently widely distributed throughout Uganda, nothing definite is at present known concerning its true carrier in nature. The presence of the disease in districts where tsetse are unknown shows that some other agent is capable of conveying this trypanosome. The behaviour of laboratory-bred *Glossina palpalis* as carriers is so uncertain that this fly would appear at most to be a facultative host, though doubtless under favourable circumstances it may play an important part in nature. Again, nothing is known concerning the existence of a natural reservoir for this trypanosome in Uganda, though Kleine has recently obtained species closely allied to, if not identical with, *T. nanum* and *T. congolense* from antelope in the neighbourhood of Tanganyika. The following experiments were undertaken with a view to discovering whether *T. pecorum* is pathogenic to antelope, and at the same time to test the power of these animals to act as a reservoir for the trypanosome:—

A young bushbuck, born at the laboratory in January, 1911, was inoculated with blood of a monkey suffering from *T. pecorum*. After an incubation period of 15 days trypanosomes appeared in the blood of the bushbuck on May 31, 1911, being present for some days and then disappearing. Clean laboratory-bred *G. palpalis* were then fed upon the bushbuck and afterwards on clean monkeys. These experiments are given in Table I. As will be seen, in only one instance was a positive transmission obtained, and this was unfortunately not entirely satisfactory, as will be explained below.

Table I.

Expt. No.	Period for which flies fed on Bushbuck 55.	Number of flies.				Length of experiment in days.	Result of feeding on clean monkey.	Remarks.
		1st day.	30th day.	Dissected during experiment.	Containing flagellates.			
112	June 6—13, 1911 ...	42	32	39	1	62	—	
129	June 9—13, „ ...	37	34	37	1	63	—	
135	June 12—14, „ ...	34	33	34	0	80	—	
247	Aug. 5—12, „ ...	93	85	90	8	141	—	
253	Aug. 7—12, „ ...	105	86	91	1	66	+	Fed on Monkey 359, which developed *T. pecorum*. *Cf. infra.*
541	Dec. 1—8, „ ...	109	56	109	0	61	—	
542	Dec. 4—8, „ ...	94	39	94	0	58	—	

The following cycle experiments were carried out in which animals other than Bushbuck 55 supplied the infecting feeds :—

Table II.

Expt. No.	Period for which flies fed on infected animal.	Number of flies.				Length of experiment in days.	Result of feeding on clean monkey.
		1st day.	30th day.	Dissected during experiment.	Containing flagellates.		
96	1911, May 31—June 5, on Monkey 152	46	44	46	1	49	—
212	1911, July 19—21, on Calf 33 ...	83	80	82	2	104	—
368	1911, Sept. 6—9, on Monkey 321	136	124	133	1	108	—
716	1912, April 18—27, on Calf 688	46	42	45	2	82	—
717	1912, April 18—27, on Calf 688	59	53	59	2	82	—

It is unfortunate that in the case of the only (apparently) successful transmission experiment (253) a possible alternative source for the trypanosome in the monkey was introduced. Owing to a temporary shortage of monkeys monkey Experiment 359, whose blood had been negative for 10 days after the last feeding of Experiment 253 upon it, was taken to the Lake. Box 253 had been dissected, and as no fly was found with flagellates in the proboscis, it was thought that the experiment would necessarily be negative. It happened that three bushbuck, A, B and C, were shot, and the citrated blood of two of them, A and B, was inoculated into the monkey, 3 c.c. from each animal. At the same time, 6 c.c., 5 c.c. and 3 c.c., citrated blood of Bushbuck A, B and C, respectively were inoculated into Goat 484. This goat remained healthy,

and examination of two blood films from each of A, B and C proved negative. Trypanosomes identical morphologically with *T. pecorum* appeared in the blood of Monkey 359 on November 13, 1911, 23 days after the inoculation of the bushbuck blood and 33 days after the last feed of Box 253. From November 1 to 10 inclusive the monkey was not examined. The trypanosomes might thus have been derived either from the bushbuck or from the positive fly of Experiment 253; in each case with a long incubation period.

The negative evidence of Goat 484 and of the blood films, together with the fact that such a trypanosome has never before been recovered from wild flies in the Mpumu district, makes it almost certain that the trypanosomes in Monkey 359 came from Fly 9 of Table III. The curious inability of laboratory-bred flies to infect monkeys with *T. pecorum*, even though showing a well marked proboscis infection, has been mentioned by Fraser and myself, and is also evident in Table III.

It is thus possible that the unusual swarming condition of the sucking stomach to be described in Fly 9 of this table may have a definite developmental significance in *T. pecorum*.

It may be noted that the trypanosomes in the monkey were characterised by a large vacuole posterior to the trophonucleus. This was very striking in the fresh state, even with low magnifications. This condition was lost in a subinoculated white rat.

A further observation which to some extent provides a parallel for the long incubation period, supposing Fly 9 to have been responsible for the infection, is afforded by Experiment 644. In the case of this monkey, inoculated from a goat suffering from *T. pecorum*, trypanosomes first appeared in the monkey's blood 26 days after inoculation. The blood in this case was examined daily. It is to be noted also that *T. pecorum* may often not be seen for days in monkeys' blood, and when present is frequently in very scanty numbers.

The curious backward condition of Fly 12 is interesting. Similar instances occurred in flies infected with *T. nanum*,* but then there was a possibility of a secondary "pick up" of trypanosomes from the calf employed. In the present instance, as the monkey of Experiment 247 never became infected, this explanation is not available.

It is to be regretted that in only three cases were the salivary glands obtained in the above positive flies. In all these the glands were negative. In this respect also *T. pecorum* shows resemblances to *T. nanum*.

A remarkable feature of the above table is the fact that no proboscis infections were obtained before the 76th day of an experiment. This delay

* "Transmission of *T. nanum*," 'Roy. Soc. Proc.,' 1912, B, vol. 85.

Table III.

Date.	No. of fly.	Age of fly when dissected.	Sex.	Expt. No.	Region of gut.						Injection.
					Hind.	Thoracic gut up to proventriculus.	Proventriculus.	Sucking stomach and duct.	Salivary glands.	Proboscis.	
1911.											
July 15 ...	1	9	♂	112	+ +	—	—	0	0	—	
Aug. 16 ...	2	11	♀	247	+ +	—	—	0	0	—	
„ 29 ...	3	24	♀	247	+ + +	+ +	—	0	0	—	
Sept. 19 ...	4	45	♂	247	+ +	+ +	+	0	0	—	
„ 19 ...	5	45	♀	247	+ + +	0	0	0	0	—	
„ 4 ...	6	45	♂	212	+ + +	+ + +	+ + +	0	—	—	
July 19 ...	7	49	♀	96	+ + +	+ + +	—	0	0	—	
Aug. 11 ...	8	63	♀	129	+ +	+ +	+ + +	0	0	—	Contents of gut and proventriculus injected into 2 white rats = negative.
Oct. 10 ...	9	64	♀	253	+ + +	+ + +	+ + +	+ + +	—	—	
„ 14 ...	10	70	♂	247	+ + +	+ + +	+ + +	0	0	—	
Nov. 21 ...	11	76	♀	368	+	+ +	+	0	0	+ + + attached long crithidia	
„ 3 ...	12	90	♀	247	+ + +	—	—	0	0	—	
„ 2 ...	13	104	♀	212	+ + +	+ + +	+	0	—	+ + 2 clusters fixed	
Dec. 5 ...	14	122	♂	247	+ + +	+ + +	—	—	0	+ + long unattached	
„ 26 ...	15	141	♀	247	+ + +	+ + +	+ +	—	0	+ + + long unattached	

In the above table the negative sign implies absence of flagellates; the sign 0 means that no observation was recorded.

on the part of the flagellates in reaching the proboscis became evident during the dissection of the earlier experiments and led to the carrying on of the later boxes for a considerably longer period. In spite of this, however, although four flies were obtained showing a good infection of the proboscis, none of these proved capable of transmitting the trypanosome to a healthy monkey. The only successful transmission, as has been pointed out above, was apparently caused by Fly 9, which showed a swarming infection of the sucking stomach and its duct. This inability on the part of the proboscis-infected flies to infect a monkey is remarkable. On several occasions the flies were starved for short periods and then again fed upon the monkey; also with negative results.

In the case of Fly 9, supposing it to be the infecting agent, two possibilities must be considered. Either the flagellates of the sucking stomach were responsible for the infection, or the proboscis may have shown a temporary infection which at the time of dissection had disappeared.

From the above experiments it will be seen that Bushbuck 55 was still capable of infecting laboratory-bred *G. palpalis* some three months after its original infection with *T. pecorum.*

The following experiments were carried out 10 months after the original infection of the bushbuck.

Date.	Expt. No.	Quantity of blood.		Result.	Animal used for injection.
		Pure.	Citrated.		
		c.c.			
21.3.12.....	670	2½		–	Monkey.
23.3.12.....	678	6		–	,,
3.4.12	688	3½		+	Calf.

In considering the positive result of Experiment 688 the following facts may be quoted as excluding any source of error:—

(1) Since my arrival in Mpumu in September, 1910, there has been no case of spontaneous infection with this trypanosome among the laboratory cattle.

(2) The cattle in the neighbourhood of the hill are apparently free from the disease.

(3) A calf of about the same age as Experiment 688 (both were born at the laboratory) has been under daily blood examination from the beginning of April until the date of writing, and has never developed trypanosomes. These two animals have never been allowed to leave the hill top, and have always been stalled together.

It will thus be seen that no local epidemic of *T. pecorum* disease, such as affected the transmission work of the 1908—1910 Commission, interfered with the above experiments.

The interesting result obtained in Experiment 688 proves that *T. pecorum* can exist in antelope for at least 323 days. During this time it apparently exerts no harmful effect upon the host. The bushbuck, Experiment 55, is to all appearances in excellent health, and has been growing rapidly throughout the period covered by these experiments.

An interesting point also is the rapid course of the disease in Calf 688, which died in 51 days. Previous to the introduction of the trypanosome into the bushbuck there were some signs that the organism was losing its influence, possibly owing to continued maintenance in laboratory animals. Thus Calf 33, which was inoculated with the old laboratory strain of *T. pecorum* from a monkey, first showed trypanosomes on May 13, 1910. The animal is still alive and in good condition, and was showing *T. pecorum* in its blood on August 29, 1910; since then the blood has not yet been examined. Bushbuck 55 was inoculated from the same monkey as Calf 33.

There is, of course, the possibility that the extraordinary course of the disease in Calf 33 is due to some immunity peculiar to this individual. Previously, all calves inoculated with this laboratory strain had died of an acute disease.

It will be noticed, however, that the long sojourn in the bushbuck did not render the trypanosome more suited to development in *G. palpalis*, in contrast to the behaviour of *T. gambiense* under similar circumstances.

Trypanosoma uniforme.

As has been pointed out elsewhere, this organism appears to be the most common antelope trypanosome in the Mpumu neighbourhood. According to Bruce and his collaborators, it causes a fatal disease in domestic ruminants, the average duration of the disease in three laboratory-infected goats being 29 days.

My experience of this trypanosome, extending over some 20 months, has not confirmed this opinion. *T. uniforme* has not proved in any way a fatal trypanosome during that time. In only one case has an animal died of an unequivocal *T. uniforme* infection, this being apparently the case with Calf 481, although for months before death no trypanosomes were visible in the peripheral blood.

A characteristic feature of *T. uniforme*, which is especially marked in goats, is the manner in which, after a few weeks, it totally disappears from

the peripheral blood as regards ordinary routine examination, while the animal shows no symptoms whatever.

When, however, this trypanosome occurs together with *T. vivax*, or possibly with *T. gambiense*, the animal may become rapidly emaciated, and die with paretic symptoms, particularly in the hind limbs. This, however, is not a constant phenomenon, as is shown in the case of Goat 512, which was infected in November, 1911, simultaneously with *T. uniforme*, *vivax*, and *gambiense*, and at the time of writing is apparently in perfect health.

The following table is of interest, as affording marked contrast to the course of disease described by Bruce:—

Expt.	Infected.	Duration of disease.	Remarks.
Goat 352.....	Nov., 1910.....	Killed Dec., 1911	In apparently perfect health at time of death.
„ 397.....	Jan., 1911	„ „	„ „ „
„ 431.....	Feb., „	„ „	„ „ „
Calf 481	Jan., „	Died in July, 1912, after 18 months	No trypanosomes visible during last week. Slight emaciation.
„ 536	Feb., „		Killed by leopard. Apparently in excellent health when attacked.
„ 573	Mar., „		Alive and well July, 1912.
„ 616	„ „		„ „
Bushbuck 620	Jan., „		In excellent health July, 1912.
Sheep 534	„ „	Up till date of infection with *T. gambiense* showed good health	Infected with *T. gambiense* in Feb., 1912. Died May, 1912.

In all the above experiments, the strain employed was derived originally from a wild bushbuck shot at the Lake shore.

The strain employed by Bruce and his collaborators was derived originally from oxen, which may explain the difference in the virulence.

Antelope as a Reservoir of T. uniforme.

Two situtunga which were brought alive to the laboratory were found to harbour this trypanosome as a natural infection.

These animals have been kept under observation, and from time to time laboratory-bred *G. palpalis* have been fed upon them. These experiments are summarised in the following table:—

Expt. No.	Period flies fed on Antelope.	Number of flies.				Duration of expt. in days.
		1st day.	30th day.	Dissected.	Containing flagellates.	
464	Oct. 10—18, 1911, on Situtunga 173	57	47	55	0	41
528	Nov. 21—28, ,, ,, 173	104	84	104	2	55
529	Nov. 22—28, ,, ,, 173	93	62	93	0	55
706	Apr. 11—17, 1912, on Situtunga 173	86	58	86	3	50
707	Apr. 12—17, ,, ,, 173	61	47	61	2	49

In all the positive flies of the above experiments trypanosomes were only found in the proboscis.

It is impossible to know when Situtunga 173 became infected, but reckoning from its arrival at the laboratory on June 25, 1911, it will be seen that the animal was still capable of infecting laboratory-bred *G. palpalis* with *T. uniforme* after a period of 10 months.

During this time the animal has remained in excellent health, though confined under by no means ideal conditions.

The question of wild antelope in tsetse regions serving as a trypanosome reservoir thus becomes increasingly important. In this Protectorate alone *T. gambiense, vivax, pecorum,* and *uniforme* have all been proved capable of surviving for a considerable time in these animals, apparently without exerting any injurious effect upon their hosts.

In other parts of Africa *T. rhodesiense, brucei, congolense,* and *nanum* have been recovered from game.

This is not the place for a discussion on the significance of the problem from an administrative point of view. Extermination of the game in Africa is a colossal undertaking, and until something more is known concerning the *rôle* played by birds and reptiles in the spread of trypanosomiasis it would seem inadvisable to set too much faith in this drastic measure.